Cardiac Rehab for Patients with Co-morbidities

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1. Introduction
2. Cardiac rehab (CR) for Patients with Co-morbidities
3. Physiatrist as a Leader of CR Program
4. Current situations in Korea
5. Take home message
• CR program can help the recovery of physical function and the secondary prevention more effectively in patients with CV disease.

• The ‘good candidate’ who can be applied exercise program without limitation can get these goals easily and safely.
1. Introduction

Effects of Cardiac Rehab Program

- **Improvement of exercise capacity**
  - Reduction of angina experience in ADL
  - Improvement of RPE (rate of perceived exertion)
  - Increase in endurance, decrease in tiredness
  - Rise of $V_{O_2}^{\text{max}}$ (20~30%↑)

- **More effective management of risk factors**

- **Gaining emotional wellbeing** (anxiety, stress↓)

- **Secondary prevention** (cardio-protective effects)

- **Reduction of CV mortality** (20~25%↓)
### Potential Cardio-protective Effects of Exercise Training

<table>
<thead>
<tr>
<th>Anti-atherosclerotic</th>
<th>Psychologic</th>
<th>Anti-thrombotic</th>
<th>Anti-ischemic</th>
<th>Anti-arrhythmic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved Lipids</td>
<td>Decreased depression</td>
<td>Decreased platelet adhesiveness</td>
<td>Decreased myocardial O₂ demand</td>
<td>Increased vagal tone</td>
</tr>
<tr>
<td>Improved blood pressure</td>
<td>Decreased stress</td>
<td></td>
<td></td>
<td>Decreased adrenergic activity</td>
</tr>
<tr>
<td>Reduced adiposity</td>
<td>Increased social support</td>
<td>Increased fibrinolysis</td>
<td>Increased coronary flow</td>
<td></td>
</tr>
<tr>
<td>Increased insulin sensitivity</td>
<td></td>
<td>Decreased fibrinogen</td>
<td>Decreased endothelial dysfunction</td>
<td>Increased heart rate variability</td>
</tr>
<tr>
<td>Increased inflammation</td>
<td></td>
<td>Decreased blood viscosity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• But, there might be ‘bad candidate’ who has many co-morbidities to hinder the participation of CR program.

• Not unusual bad scenario

  Sickened heart + Sedentary lifestyle + Age related ↓ in fitness + MS problems + etc.
  → less and less reserve for ADL & social activities
  → de-motivated for risk factor control
  → recurrence, complications, & death
Many Patients have Multiple Co-morbidities

<table>
<thead>
<tr>
<th>Medical comorbidities</th>
<th>Physical comorbidities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus</td>
<td>Low limb amputation</td>
</tr>
<tr>
<td>End-stage renal disease</td>
<td>Stroke hemiplegia</td>
</tr>
<tr>
<td>Severe COPD</td>
<td>Paraplegia</td>
</tr>
<tr>
<td>Geriatric patient</td>
<td>Musculoskeletal pain</td>
</tr>
</tbody>
</table>

- In case of multiple co-morbidities, exercise-based CR might be rejected by medical staff due to safety and complexity or by self-giving up.
- Aerobic exercise training is more desperately needed for patients with multiple co-morbidities.
# Introduction

## Overall Increase in Risk

<table>
<thead>
<tr>
<th></th>
<th>MI</th>
<th>Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI</td>
<td>5-7</td>
<td>3-4</td>
</tr>
<tr>
<td>Stroke</td>
<td>2-3</td>
<td>9</td>
</tr>
<tr>
<td>PAD</td>
<td>4</td>
<td>2-3</td>
</tr>
</tbody>
</table>

MI: myocardial infarction  
PAD: peripheral artery disease

2. CR for Pts with Co-morbidities

<table>
<thead>
<tr>
<th>Functional Classification</th>
<th>Therapeutic Intermittent</th>
<th>Continuous</th>
<th>kcal/min (70 kg subject)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>( V ) Heavy 10-12.5</td>
<td>( H ) Heavy 7.5-10</td>
<td>( A ) Mod 5-7.5</td>
</tr>
<tr>
<td>Energy Expenditure</td>
<td>( 12 )</td>
<td>( 9 )</td>
<td>( 7 )</td>
</tr>
</tbody>
</table>

**Human Energy Expenditure: Frame of Reference**

- Running
- Cardiac Stress Test
- Brisk Walk
- CWS (80 m/min)
- Standing/Sitting

BMR
CR in Lower Limb Amputee

• Prosthetic ambulation even in a trained individual is a high-energy cost physical activity.

• Knowing the NYHA functional classification, one can estimate the cardiac functional capacity and the patient's ability to ambulate with a prosthesis.

• In cardiac lower limb amputee, before starting preprosthetic ambulation training, the cardiac capacity can be assessed by upper extremity ergometry.
## Energy Cost of Amputee Ambulation
*(percentage increase above normal [3METs]*)

<table>
<thead>
<tr>
<th>Amputation Type</th>
<th>Increase (%)</th>
<th>MET</th>
</tr>
</thead>
<tbody>
<tr>
<td>No prosthesis, with crutches</td>
<td>50</td>
<td>4.5</td>
</tr>
<tr>
<td>Unilateral BK with prosthesis</td>
<td>9-28</td>
<td>3.3-3.8</td>
</tr>
<tr>
<td>Unilateral AK with prosthesis</td>
<td>40-65</td>
<td>4.2-5.8</td>
</tr>
<tr>
<td>Bilateral BK with prosthesis</td>
<td>41-100</td>
<td>4.2-6.0</td>
</tr>
<tr>
<td>BK + AK with prosthesis</td>
<td>75</td>
<td>5.3</td>
</tr>
<tr>
<td>Bilateral AK with prosthesis</td>
<td>280</td>
<td>11.4</td>
</tr>
<tr>
<td>Unilateral hip disarticulation with prosthesis</td>
<td>82</td>
<td>5.5</td>
</tr>
<tr>
<td>Hemipelvectomy with prosthesis</td>
<td>125</td>
<td>6.75</td>
</tr>
</tbody>
</table>

Flores et al: Rehabilitation of the Cardiac Patient, 1998
2. CR for Pts with Co-morbidities

**Correlation of the Energy Cost of Ambulation**

<table>
<thead>
<tr>
<th>NYHA* Class</th>
<th>MET</th>
<th>Amputee ambulation</th>
<th>MET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class IV</td>
<td>&lt; 2</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Class III</td>
<td>2-5</td>
<td>Wheelchair</td>
<td>2.0-3.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unilateral BK prosthesis</td>
<td>3.3-3.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unilateral AK prosthesis</td>
<td>4.2-5.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bilateral BK prosthesis</td>
<td>4.2-6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BK and AK prosthesis</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unilateral hip disarticulation prosthesis</td>
<td>5.5</td>
</tr>
<tr>
<td>Class II</td>
<td>5-7</td>
<td>No prosthesis, just crutches</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unilateral AK prosthesis</td>
<td>4.2-5.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bilateral BK prosthesis</td>
<td>4.2-6.0</td>
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<td>BK and AK prosthesis</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hemipelvectomy prosthesis</td>
<td>6.75</td>
</tr>
<tr>
<td>Class I</td>
<td>&gt; 7</td>
<td>Bilatereal AK prosthesis</td>
<td>11.4</td>
</tr>
</tbody>
</table>

* NYHA: New York Heart Association

Flores et al: Rehabilitation of the Cardiac Patient, 1998
CR in Stoke Survivors

- CV comorbidities are common among stroke survivors.
  - Hypertension in 50~84% / Heart disease in up to 75%
- Patients with stroke are severely deconditioned, leading to metabolic abnormalities that significantly increase risk for AMI and recurrent stroke.
- A trained hemiplegic patient walks at a speed that is 40-45% slower than the normal individual, yet the energy cost of ambulation is 50-65% higher.

• Conventional stroke rehab during the subacute phase
  - Optimizing basic ADL skills,
  - Developing functional independence,
  - Preventing complications

• Conventional stroke rehab does not provide adequate aerobic stimulus to reverse the profound physical deconditioning and hemiparetic muscular atrophy that worsen neurological disability and CV health profiles in this sedentary population.

Practical Challenges of Exercise Training for Stroke Patients with Cardiac Problem

- Check the level of neurological deficits following stroke.
- Consider high associated energy costs.
- Must know the CV response to exercise stimulation.
- High risk patient to exercise should be classified.
- Need alternative exercise modalities.
- Need lower patient-to-staff ratio & additional training.
- Monitoring should be done during exercise training.
Adapted equipments and protocols have been developed for exercise test and training of people after stroke.

Motorized Active Passive Exerciser

Treadmill Exercise Rehab Improves Ambulatory Function and CV Fitness in Stroke Survivors

Figure 2. Between-group comparison of peak aerobic capacity across 6 months. There was a significant time by group interaction in VO$_2$ peak (mL/kg/min) by repeated-measures ANOVA (†$P<0.005$). VO$_2$ peak was significantly different from baseline at both the 3-month and 6-month time points within the T-AEX group (⁎$P<0.05$). Values are mean±standard error.

(Richard et al; Stroke, 2005)
2. CR for Pts with Co-morbidities

CR in Patients with SCI

- Because of advances in medical technology and improved health maintenance, patients with spinal cord lesions now live longer.

- Along with SCI sequelae, many SCI patients are susceptible to the diseases of aging.

- One third of SCI patients older than 65 years and nearly half of the patients with SCIs exceeding 30 years' duration die of cardiovascular diseases.

Reduced Exercise Capacity in SCI

- Loss of muscle pump action causing decreased venous return
- Muscle weakness or atrophy
- Altered respiratory system function
- Small cardiac chamber size
- Greater use of type II overt Type I muscle fibers
- Sedentary life style
- Impaired autonomic nervous system
- Impaired neuro-system control
- Altered hormonal effects
- Potential co-morbidity from infection, skin breakdown, etc
Exercise must be highly individualized.
- Treatment goals / Levels of injury
- Strength / Aerobic capacity / ROM / Spasticity
- Balance / Trunk control / Risk of falls & fracture
- Risk of overuse / Fatigue / Thermal instability
- Autonomic dysfunction

Various exercise modes can be used.
- Wheelchair propulsion
- Arm ergometry
- Wheelchair cycling using arm cranks
- Hybrid exercises involving arm ergometry + L/E FES

2. CR for Pts with Co-morbidities

Routines for CR in Physical Co-morbidities

- Must check CV disease status & severity
- Exercise test for exercise risk classification, exercise prescription, & F/U evaluation
  - By treadmill (walking or WC), arm ergometry
  - Pharmacologic stress test / Thallium scan
- Prepare adapted equipments & protocols
- Monitoring during exercise training
- Periodic evaluation of modifiable risk factors
  - Serum lipids / Oral glucose tolerance
  - Weight / Blood pressure / Dietary habits
  - Smoking / Activity level / Alcohol consumption
  - Annual EKG screening in aging SCI
• LBP and lower limb pain often hinder exercise.

• Neurogenic claudication due to spinal stenosis is often confused with vascular claudication.

• Comprehensive managements including physical therapy, medication, pain block, specific exercises or rarely surgery might be useful.

• The purpose of pain control is to keep exercise enough to get the goal of CR.
3. Physiatrist as a Leader of CR

Roll of Physiatrist as a Leader of CR

1. Director of comprehensive CR program
2. Supervising physician
3. Exercise physiologist
4. Conductor in the processes of
   1) program development, quality improvement, & operations
   2) patient referral
   3) patient evaluation and goal development
   4) program monitoring & exercise supervision
   5) strategies to facilitate compliance
5. Physiatrist as a manager of multiple co-morbidities
3. Physiatrist as a Leader of CR

Sites of Action of Exercise Training

Peripheral Training Effects

Cardiac Training Effect < 10%

Mental System
- quality of life ↑
- anxiety/depression ↓

Respiratory System
- respiratory muscle strength ↑
- tidal volume ↑
- Ve/VO₂ slope ↑

Neurohumoral System
- sympathetic activity ↓
- vagotonus ↑
- ergoreflex activity ↓

Vascular System
- endothelium-dependent vasodilation ↑
- vascular resistance ↓

Skeletal Muscle System
- oxidative metabolism ↑
- mitochondrial density ↑
- atrophy ↓
| 1. Director / supervising physician |
| 2. Program coordinator |
| 3. Exercise physiologist & specialists |
| 4. CR specialized nurse |
| 5. Physical & occupational therapists |
| 6. Dietitian or nutritionist |
| 7. Clinical psychologist |
| 8. Vocational counselor |

* All personnel must be certified in BLS.
4. Current Situations in Korea

What Should We Physiatrists Do?

- Prepare & set-up CR program in your hospital.
- Conduct all team members of CR program.
- Educate CR staffs, patients, and family.
- Further study and research for CR (single or multicenter).
- Persuade government for reflecting medical reimbursement & policy to develop CR nationwide.
- Develop adapted equipments and programs for exercise test & training for specific co-morbidities.
There’s still poor consensus for CR among MDs.

Patient and family do not have an idea for need CR.

Many patients do not like or even hate keeping exercise.

Lot of patients have no enough time for participating CR.

There are very few facilities, equipments, and staffs for CR.

CDC & HIRA recognized the importance of CR very recently.

NHIC has not reimbursed medical costs for CR program yet.
Take Home Messages

• CR program is effective not only for improving exercise capacity but also secondary prevention.

• Co-morbidities bothering exercise-based CR must be evaluated and managed.

• CR program can be adapted and modified for patient with disability with the same training principles.

• We physiatrist must develop and prepare the best way for them to participate in CR program actively.